

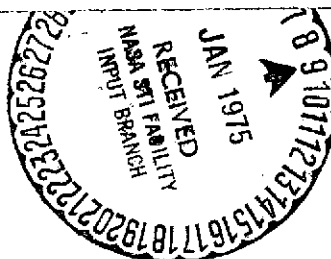
MISSION AND ORGANIZATION OF THE DFVLR: TWO YEARS OF INTEGRATED  
SOCIETY OF GERMAN AERONAUTICAL AND SPACE FLIGHT RESEARCH

Volker Aschoff

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15. Supplementary Notes Translation of "Ueber die aufgabe und die organisation der DFVLR - Zwei jahre einheitsgesellschaft der Deutschen Luft- und Raumfahrt- forschung" .:			
16. Abstract A historical review on organizational developments of the German aeronautical societies is followed by a description of management methods for modern aerospace research facilities. The development history of the German Society for Aerospace Research is outlined and its scientific and geographic organizations are described. The various institutes of the society are assigned individual research on flow mechanics; flight mechanics and control materials and construction; propulsion and energy electronics and aerospace physics, simulation, and medicine.			
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5 MISSION AND ORGANIZATION OF THE DFVLR: TWO YEARS OF INTEGRATED  
SOCIETY OF GERMAN AERONAUTICAL AND SPACE FLIGHT RESEARCH

Volker Aschoff

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I. HISTORY OF AERODYNAMICS AND SPACE RESEARCH FACILITIES IN  
GERMANY UP TO 1969

There was a time in which human beings were able to make fundamental discoveries using creative intuition alone. The plow was used for agriculture, the hammer was used as a tool, the wheel was used as a means of transportation but also the bow and arrow only required an inventive mind and manual dexterity for their realization.

As technology develops further, more and more there are cases in which true progress can only be produced when there is sufficient scientific knowledge. The development of the steam engine was based on advances in thermodynamics, and the development of electrical technology was based on advances in theoretical electrical theory. Technical advances and scientific research interacted continuously, especially in the 19th century.

As man started to conquer the air, at the end of the 19th century and at the beginning of the 20th century and when he started to investigate a new area, a new situation resulted. When

\* Numbers in margin indicate pagination in original foreign text.

Graf-zeppelin had carried out one of the longest flights over land and as the brothers Wright developed the art of flying of Otto Lilienthals, the large industrial nations were exposed to a new area: aviation. For its development, it was no longer sufficient to consider only the general results of scientific research. It was necessary to carry out directed research in order to provide the scientific requisites for the technical advance.

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1907	Model Test Facility, Goettingen (Later on, AVA)
1912	German Test Facility for Aviation (DVL) Berlin Adlershof
1924	German Research Facility for Gliders (DFS) Darmstadt
1936	German Research Facility for Aviation (DFL) Braunschweig
1937	Aviation Radio Research Institute (FFO) Oberpfaffenhofen
1953	German Research Facility for Helicopters and Vertical Flight Technology (DFH) Stuttgart
1954	Research Institute for Physics and Jet Propulsion (FIPS) Stuttgart

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DFVLR	The early history of the DFVLR	A 023 1970
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In this connection, in 1907 the "Model Test Facility for Motor Driven Airships and Study Association" was formed in Göttingen. Already in 1897 Felix Klein founded the "Göttingen Association for Advancing Applied Physics and Mathematics", in order to intensify the relationship between the scientific, educational and research facilities and persons in industry. Göttingen, at the beginning of the century, was ideally suited for

developing an application-oriented fundamental research complex, as one would say today.

The model test facility was soon world famous because of the scientific direction of Ludwig Prandtl and because of its fundamental work in the area of fluid mechanics. In 1918 it was accepted into the Kaiser-Wilhelm association for the advancement of science and was given the name "Aerodynamic Test Facility".

Even though the fluid mechanical fundamentals were very important for the further development of aviation, they were not sufficient for providing a technical advance of aircraft design. /117 Additional theoretical fundamentals and additional test facilities had to be provided for this, which should involve as many firms as possible involved in aviation. Suggestions of Grafen Zeppelin and several initiative proposals caused the German Reichstag to found a Reichs Association for Airship Travel and Flight Technology in the year 1910. Based on the commemorative papers of Hergesell, Prandtl and Bendemann and under the direction of the Reichs Commission for the Interior, the "German Test Facility for Aviation" was established in Berlin-Adlershof. Its task was to "support German aviation and German airship transport by production, development and maintenance of a test facility for the common cause". The entity was not founded as a Reichs facility but had the legal organization of a registered association, in order to provide true partner relationships between the state, science and business. The DVL was therefore the first example of such fruitful collaboration for advancing a newly developing branch of technology.

Finally, the Munich professor, Dr. Dieckmanns, himself funded the "wireless telegraph and air-electrical test facility in Gräfelfing", and there performed investigations on the suitability of electromagnetic waves for communications in aviation technology.

After losing the First World War, the further development of motor driven aircraft was very difficult in Germany because of restrictions by the victorious powers. This led to the development of glider aircraft and in the year 1924 the "German Research Facility for Gliders" was founded.

Soon motor driven aviation progressed even further. After overcoming the world-wide economic crisis, the research capacities of the AVA and the DVL were no longer sufficient. In the year 1936, an additional installation was founded, the "German Research Facility for Aviation" in Braunschweig, which worked closely in collaboration with the Technical University in Braunschweig, and carried out advanced scientific research.

The increased importance of wireless communications in aviation resulted in the formation of an "Aerodynamic Radio Research Institute" in the year 1937, which was to provide a continuation of the entity funded by Dr. Dieckmanns before the first World War.

It seemed as though the loss of the second World War and the restrictions regarding any kind of aviation research by the control law No. 25 would put an end to all these institutions and test facilities. Part of the scientists and workers were able to continue the tradition at least in an indirect way. In 1953 the AVA started again in Göttingen, the DFL in Braunschweig, and the DVL in Aachen, Mülheim and Oberpfaffenhofen and continued their research work.

During the same year the state Baden-Württemberg founded the "German Research Facility for Helicopters and Vertical Flight Technology" in Stuttgart-Echterdingen. One year later, 1954, because of Eugen Sänger, the "Research Institute for Physics of Jet Propulsion" was founded in Stuttgart-Vaihingen.

The research work in the old facilities was continued and the new associations were formed during a time when spaceflight was also developing as a new technology in addition to traditional aviation. Therefore, the question was raised of whether independent research facilities should be developed for this scientific and technical work or whether the existing aviation research facilities should be extended to include spaceflight.

The last solution was adapted. It led to a fusion of the research facilities in a single association: the "German Research and Test Facility for Aerodynamics and Spaceflight". This was done in conjunction with a continuing fusion of the individual installations.

## II. TASKS OF THE DFVLR ACCORDING TO REGULATIONS

<p style="text-align: center;">DFVLR</p> <p style="text-align: center;"><u>German Research and Test Facility</u> <u>for Aerodynamics and Spaceflight e.V.</u></p> <p>Research in the area of aerodynamics and spaceflight  Collaboration in the planning and execution of projects  Building an operation of large scale test facilities  Further development of young scientists  Consultation with Federal West German agencies</p>		
DFVLR	Tasks of the DFVLR	A 021 1970

The DFVLR was assigned the following tasks following the tradition of previous associations, and these were primarily in the area of aerodynamics and spaceflight:

- 2 a) To carry out research by maintaining research institutes,  
3 b) To carry out and plan projects, /120  
4 c) To build and operate large test facilities  
5 d) To further educate young scientists in collaboration with  
scientific universities  
e) To give support and consultation for the appropriate  
agencies in West Germany.

In detail the following is to be done:

a):

The DFVLR provides application-oriented fundamental research and applied research with the following goal:

- to provide scientific fundamentals for future developments,
- to provide scientific support for ongoing developments,
- to provide scientific criteria for decisions as required.

For this purpose, freely selectable research projects are processed at the institutes of the DFVLR, as well as research projects assigned by the Federal and State governments, as well as research tasks agreed upon with third parties.

Most of the research projects processed by the DFVLR deal with problems of aerodynamics and spaceflight. This led to pioneering work in many areas because of the new and difficult nature of the problems, which had a stimulating effect in other areas of the natural and engineering sciences and in conventional technological areas. The yearly reports of the DFVLR show that in addition to the research work performed in the special areas of aerodynamics and spaceflight, these results have also been applied to questions associated with

1 anthropotechnology, bionics, processing techniques, analysis and  
2 suppression of dangers resulting from advances in technology,  
3 and finally the basic problems of systematic planning and develop-  
4 ment of planning methods. /121

5 b):

Later on I will discuss the planning and execution of projects.

c):

Part of the research tasks can only be carried out if there are available special large scale facilities, such as wind tunnels, space simulation chambers, etc. The task of building such large scale test facilities assigned to the DFVLR represents quite a difficult task. The solution of this task must be looked upon as a very significant engineering feat. This task of the DFVLR was extended over the last few years to include a new problem, the building and operation of ground stations required for carrying out and evaluating scientific satellite missions. This is a scientific service operation and its development and preparation requires special engineering work, just like in the large scale facilities.

d):

The task of developing young scientists presupposes a pre-collaboration with the scientific universities. Here again the DFVLR continued a tradition which was established for their mutual interest previously.

The following numbers may point out how good this collaboration was:

/122

- In the 2 1/2 years since the founding of the DFVLR, 4 scientists have been called to accept a chair at a scientific university.
- 3 scientists have become full professors at scientific technical universities,
- 5 scientists have obtained the title of honorary professor or professor,
- 18 scientists lecture at scientific universities and
- 56 scientists were promoted.

### III. STRUCTURING BY DISCIPLINE AND LOCATION

The formal requirement of primarily carrying out work and research in the area of aerodynamics and spaceflight covers a large area of disciplines in the natural and engineering sciences. Appropriate planning and coordination of the research projects and intensive experience exchange will be useful among institutes which work on similar or identical projects. For this reason, the institutes of the DFVLR were grouped into six scientific areas, just after the fusion took place. These are the following:

Scientific area 1.	Fluid dynamics
Scientific area 2.	Flightmechanics and flight control
Scientific area 3.	Strength, materials, construction techniques
Scientific area 4.	Propulsion and energy
Scientific area 5.	Electronics
Scientific area 6.	Air space physics, space simulation, flight medicine.
DFVLR	Research Divisions within the DFVLR (1970)
	A 045 1971

Fluid mechanics

with 8 institutes at the present time

Flight mechanics and flight control

with 4 institutes at the present time

Strength, materials, construction techniques

with 4 institutes at the present time

Propulsion and energy

with 9 institutes at the present time

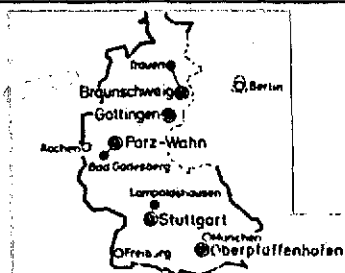
Electronics

with 2 institutes at the present time

Airspace physics, space simulation and flight medicine

with 3 institutes at the present time.

This division is based on the activities of the German Association for Flight Sciences, which took on the assignment of a coordinated covering agency for the previous facilities during the years before the DFVLR was founded. The division and names of the scientific disciplines are not entirely logical, but it has been found to be useful during the first 2 1/2 years of existence of the DFVLR.



- Research center
- Outside facilities
- ◐ External institute near technical university

DFVLR	Research facilities of the DFVLR	A 001 1969
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The geographical structure was specified by the previous history of the DFVLR. The AVA was founded in Göttingen and could resume work there after the war. The DVL was originally

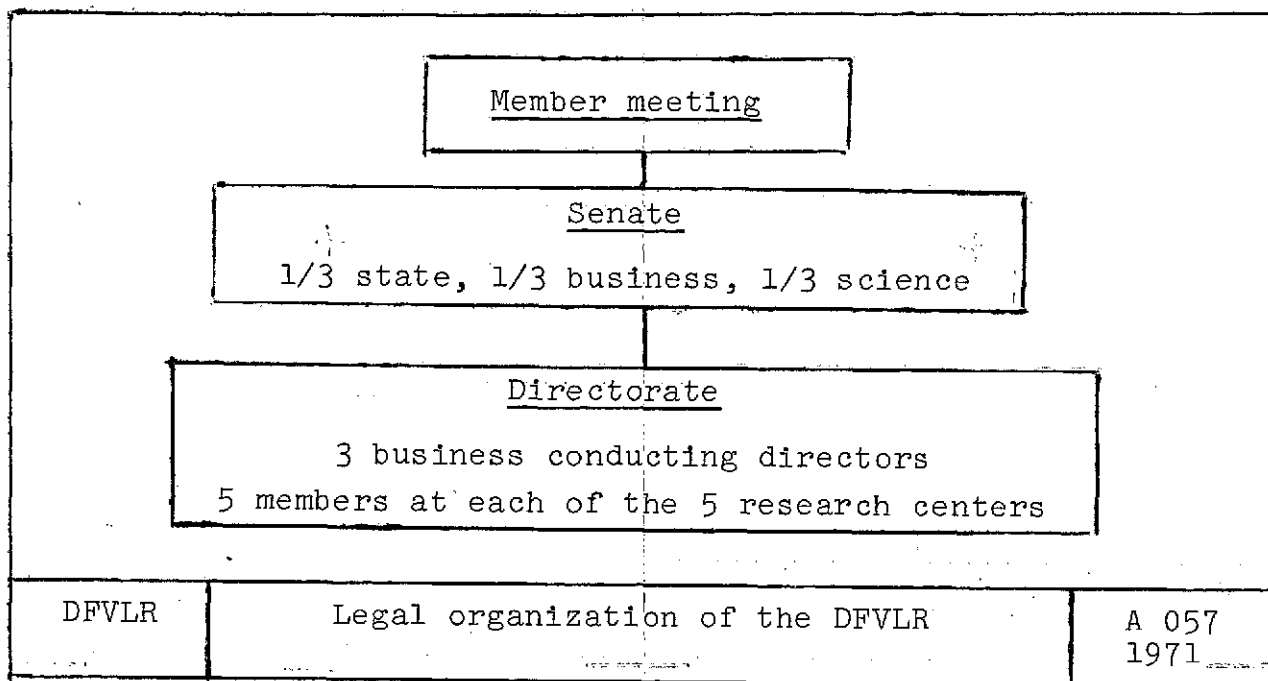
in Berlin-Adlershof, but after the war, started up again in Nordrhein Westphalia and Bavaria and later on took over the Institute for Physics and Jet Propulsion in Stuttgart. The DFL had been founded in Braunschweig, but again started there after the war and later on took over the German Research Facility for Helicopters and Vertical Flight Technology, as well as the Institute for Construction and Construction Technique Research in Stuttgart. In conjunction with the development of the third stage of the Europa rocket, the DFL built rocket test stands at the old external facility in Tauen in the Lüneburger Heide. The DVL continued to expand the test stands in Lampoldshausen, originally built by Sanger. Finally the DVL built facilities near technical universities in Berlin, Aachen, Freiburg and Munich.

	RS	GO	PU	S	OP	HAAS
Fluid mechanics	1	3	1			3
Flight mechanics/flight control	2				1	
Strength/materials	1	1	1	1		
Propulsion/energy	1		1	1		1
Electronics					2	
Airspace/flight medicine			2		1	
Aerodynamics	2				2	
Spaceflight	1		1	1	2	
Central facilities	RZ	RZ	SI	AS	RZ	SLD1
DFVLR	Local and specialized structure					A 044* 1971
of the DFVLR (Status 1970)						

The initial position of the DFVLR was therefore a structure based on scientific discipline for the most part as well as the geographic scatter dictated by the previous history.

Three organizational problems resulted because of the double task of carrying out research and also providing planning and execution of projects which will be discussed in the following section.

#### IV. -- ORGANIZATION FORMS OF THE DFVLR



Just like the previous associations, the legal entity of the DFVLR is a registered association.

The supporting members of this registered association include the Federal government and the 4 State governments, in which the research facilities of the DFVLR are located. Also it includes 50 industrial firms in the area of aerodynamics, space technology and other areas of technology, which can be relevant directly or indirectly for research work of the DFVLR. Based on this particular scientific performance, single persons can be given a title of scientific member.

The legal organization provides the member association as the uppermost entity in the organizational structure. It selects the senate, which is composed of 1/3 each of members from the state, business and scientific community.

The legal organization of the registered association and the composition of the senate therefore document the basic idea which was important from the beginning for the previous associations, as well: There shall be a true partnership and collaboration among the state, business and the scientific community for the common good.

The most important task of the senate is to select the directors at the request of the member association and to monitor them. The senate uses two panels for support: the scientific-technical panel and the personnel and financial panel.

Scientific workers of the facilities are elected to the senate as well as to its panels in order to provide transparency to all decisions of these panels.

The legal organization of the DFVLR is only to provide an external framework for the activity of the facility.

#### Scientific Discipline Panels and Main Panels

Research planning and scientific coordination of institutes — collaboration of scientists

✦ Aerodynamic area, ✦  
Spaceflight area

Object and project-related interdisciplinary coordination.  
Use of large scale facilities.

#### Research Centers

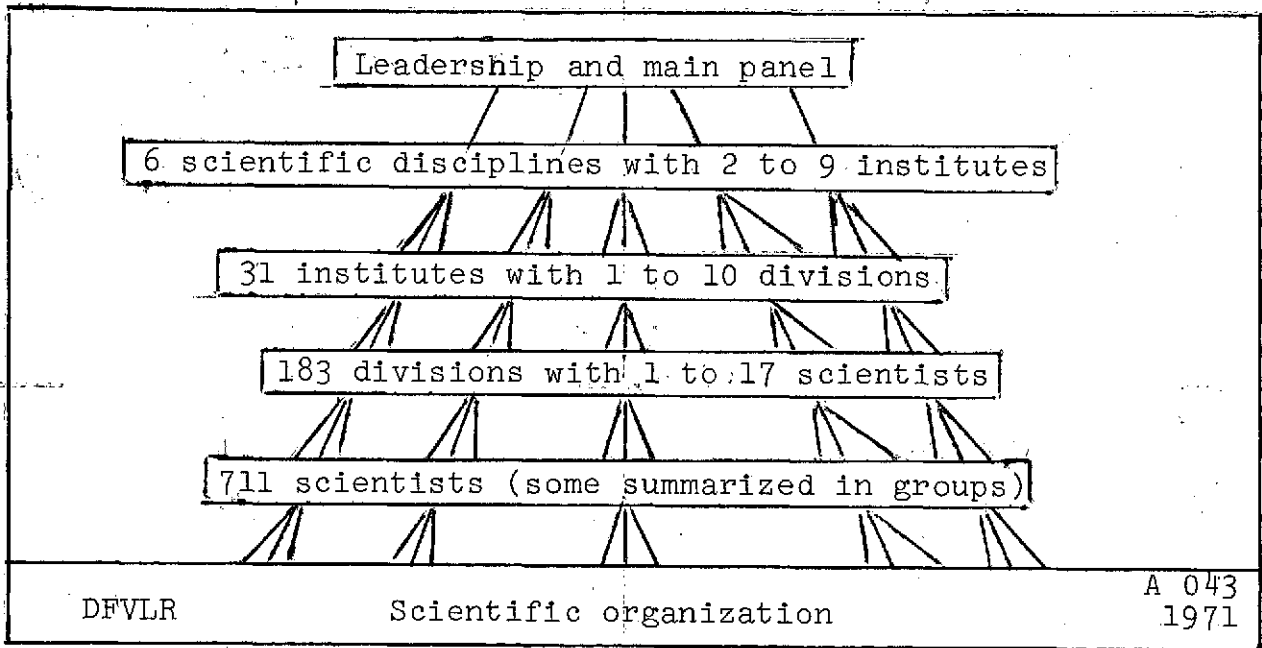
Infrastructure — central services and facilities

DFVLR	Organization of the DFVLR	A 056 1971
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1  
2 In the first 2 1/2 years, three complexes have resulted for  
3 the activity of the DFVLR, which have their own organizational  
4 structure.

/127

5 The first consists of planning, coordination and evaluation  
of research results. This task directly and decisively affects  
the activity of each individual scientific worker and here we  
have the most important area of scientific collaboration.



1 The modern management and organization assume that for a  
2 high quality mental activity, the organizational widths and  
3 organizational depths on the average are solved by personnel  
4 structures at a ratio of 1:6.

5 The forms of optimal functional structures have been  
verified by the continuing collection of scientific workers of  
an institute into divisions as well as the collaboration of  
scientifically related institutes in certain special areas.  
According to experience, this has proven itself. Except for the  
coordination of scientific disciplines in the main panel for  
planning and structure, numerical ratios result which are very  
close to 1:6 on the average, and no rigid structure is prescribed.

The collaboration of the scientists is provided by the fact  
that the divisions participate in the scientific work of the  
institute through the division leaders and an equal number of  
selected scientific workers in the institute assembly. Each  
institute is represented by an institute director and an elected  
scientific worker in the appropriate special scientific discipline  
panel.

The scientific workers are represented according to their  
parity in the coordination of research between the technical areas  
within the main assembly for planning and structure. Each of the  
six technical boards sends a speaker selected from the institute  
directors as well as an alternate speaker selected from the  
scientific workers to the main board.

The main board and the directorate represent a panel which  
corresponds to the scientific-technical directives advisory board  
of the Federal Ministry for Education and Science. The fact that  
there is a stepped structure of divisions above the institute  
and specialist boards up to the main board insures that the

knowledge of modern management methods is considered to a great extent.

We will again defer the question of the tasks involved during participation in projects. We will discuss the second organizational task, the preparation of the administration required for work at the institutes, the infrastructure and the technical services at the research centers. The geographically-based requirement for decentralization of certain tasks, contradicts the desire for a uniform type of organization with strong centralization of these tasks.

There remain a number of questions within the centers as well as among the centers and the main administration which remain to be solved. Everywhere these problems have an effect on every day work procedures, the participation of the operational directorate in a solution of these tasks represents a justifiable wish of the scientific workers at the DFVLR.

I will now discuss the problem of collaboration in the planning and execution of projects. I would like to point out that by project we mean a task which is to be performed in certain sequential phases and has as its goal the development of a concrete entity, such as a space vehicle.

<u>Planning phases</u>	01 studies on future programs	
	02 program definition	
<u>Project phases</u>	A Determination of whether various concepts are realizable.	
	B Project definition of a selected concept	
	C Design, cost and time plans	
	D Development, production, delivery	
	E Start-up and operation	
DFVLR	Phased execution of a spaceflight project	A 059 1971

When the institutes of the DFVLR are to collaborate during the planning and execution of aviation projects or space projects, then it is necessary to have interdisciplinary object-related and project-related coordination among the subject areas within the institute. The aerodynamic and space technical divisions are used as organizations for these tasks.

Aerodynamic Division

Central division for design research in aviation

Central division for aviation technology

Spaceflight Division

Working group for general spaceflight projects

Central division for satellite operation

Mobile rocket launch sites

DFVLR	Interdisciplinary coordination and scientific service facilities	A 004 1971
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In the aerodynamic area, the central division performs an advisory function at the present time for preparing future aerodynamic projects. The Central Division for Aviation Technology deals primarily with questions of safety of aircraft and the economy of transport systems. /130

Within the spaceflight area, the general spaceflight project working group has the task of interdisciplinary coordination. The German ground installations required for operation of research satellites and probes are summarized under the satellite operation-central division. The mobile rocket launchsite division supports the extraterrestrial research of scientific institutes by launching high altitude research rockets from foreign launchsites.

Association for Space Researchm. b. H.Location: Bonn-Bad Godesberg

- Goals:
- a) Support of the National Spaceflight Research by specifying and coordinating development tasks.
  - b) Execution of the tasks which result as part of [the] participation of West Germany in the ELDO and ESRO Programs.

DFVLR	Association for Spaceflight G f W	A 013 1970
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Within the spaceflight technology and spaceflight research area, over the last few years a number of concrete projects have been carried out or started. A special association, the association for spaceflight research, was founded for planning and carrying out these projects, as far as the tasks of the customer are concerned.

In addition to the national development projects, the GfW also carries out tasks which are the result of participation of West Germany in international programs.

Tasks of a Project Directorate

In the areas

- Payload (experiments)
- Space vehicles
- (Launch vehicles)
- Operation

Responsible for planning and control of

- Technology (specification, tests, quality control)
- Deadlines
- Costs

DFVLR	Customer management for spaceflight projects (CfW)	A 064 1971
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The GfW lets contracts of the West German government for national spaceflight projects supported by the federation. A project directorate is formed for each project which is responsible for planning and control of specifications, of tests, for quality control, deadlines and costs. If, for example, we are dealing with a space vehicle, then in addition to the space vehicle itself, the project directorate is responsible for the payload, the launch and the operation. / 132

#### Tasks of a Project Scientist

- 1) Coordination of criteria for scientific success of mission.
- 2) Coordination of experiments for maximum scientific gain.
- 3) Coordination of experimentors and the overall goal of the project
- 4) Collaboration during preparation of scientific data

DFVLR	Management tasks for scientific spaceflight missions	A 065 1971
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If we are dealing with a research satellite, such as the AZUR or the AEROS or a research probe such as the HELIOS, then in addition to the technical-administration tasks, the project directorate must also provide the scientific coordination of the experiments by means of a project scientist. This begins by unifying the criteria for the scientific success of the planned mission and extends over the coordination of the experiments and experimentors up to the participation when scientific data are prepared.

Since the GfW does not have its own laboratories and test facilities, since the formation of the DFVLR, there has been a collaboration treaty between the two institutes, which makes possible a coordinated use of the facilities of the GfW and the

DFVLR. In the future this collaboration will be intensified further because the DFVLR will take over the business management of the GfW and will direct it as a subordinate organization in the future. The closer collaboration of the DFVLR and the DfW is to bring about two things: first of all, for the international collaboration of West Germany in the area of spaceflight, a unified complex will be formed to operate as a discussion and working partner. The mobility of the scientific collaborators will be enhanced. They are continually operating in various ways as project managers and are confronted with the practical necessities of technical realization. They can also participate in the systematic research of scientific tasks at the institutes. This will bring about various innovations between theory and practice.

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AWF

Working group for spaceflight research

(Association of Institutes of the Max Plank Association and the DFVLR)

Location: Munich

Goals: Common technical and scientific preparation of experiments in extraterrestrial research (high altitude rockets and satellites).

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DFVLR	Working group for spaceflight research - A w F	A 014 1970
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As a conclusion of this section on the work of the DFVLR during planning and execution of projects, we would like to point out that there is an Association of Institutes of the Max-Planck Association and the DFVLR which is concerned with the technical and scientific preparation of experiments in extraterrestrial

research. This working association for spaceflight maintains an office in Munich. /134

Finally, in our chapter about the organizational forms of the DFVLR, we should note that corresponding to the collaboration of the scientific workers in the research planning and the participation of the directorate in all questions of the daily work, the state has also reserved itself the right for directing work in spaceflight projects.

#### V. SPECIAL PROBLEMS OF RESEARCH MANAGEMENT

The size and complexity of the DFVLR required several organizational forms which penetrate each other to be established, which were discussed in the previous section. The large expenditure in personnel and money, which today must be maintained for large scale research, requires us to devote special attention to the problems of research management. I would like to mention three examples from this area.

The first example concerns the natural desire of the financial supporters, in other words, in the case of the DFVLR, the parliaments and ministries of the federation and the states, to have formal control of foreign expenditures through the Federal Financial Ministry as well as a control on the scientific efficiency of any improved projects or support. The method which has been adapted amounts to a control of performance of research projects. /135

<u>Nominal: Research plan</u>		<u>Actual: Yearly report</u>
Topic and topic number		Topic and Topic number
Begin and plan conclusion		Scientific activity proof
Relationship to the space research plan of the ministries		Publications; research reports lectures
Scientific contacts		Reasons for deviations from the research plan
Customers, financial supporters		Names of the collaborators
Planned personnel, material and money expenditures		
DFVLR	Nominal-actual value comparison in the "success check" control loop.	A 042 1971

In the first approximation a success control can consist of a repeated comparison between the nominal value of a research plan and the achieved actual value of the research work carried out performed at certain time intervals.

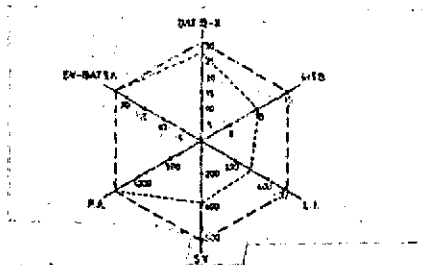
In order to give the DFVLR members and the organs to be used by the member association and the supporting ministries, the opportunity for such a comparison, the DFVLR every year publishes a detailed research plan and a yearly report. The research plan contains the research topics ordered according to scientific disciplines and institutes. It specifies the beginning and planned conclusion of the work, the relationship between the topic and the so-called overall framework research plan, in which the ministries can specify the research tasks which they desire. Also it gives the contacts with other scientific installations, the customers if this deals with a research project of third persons, as well as finally the plan expenditures in personnel, materials and money.

The yearly report uses the same corresponding topic numbers to relate to the research plan of each year. It reports the research tasks carried out in the report year in the sense of a scientific activity verification. It justifies the necessary deviations from the research tasks and also contains the names of the collaborators, as well as a complete list of publications, reports and lectures of the individual institutes.

The design of the research plan is presented to the member firms and the ministries for evaluation. It is detailed because of a requirement for a very highly detailed representation required by the supporting ministries. Also the participating firms would prefer a somewhat looser summary of the individual topics into topic groups. The research plan, 1971, contains 582 research topics ordered according to 31 institutes, as an example. This means that, on the average, there is somewhat less than 20 individual topics per institute. The yearly report 1970 recently appeared and is available in book stores. It reports on the work of the institutes, the scientific service organizations and central facilities and corresponds to the research plan 1970.

Number of scientific collaborators	SV ... NAT 124	
Number of other employees	NAT 123	
Number of salaried persons	MTA	
Personnel expenses in kDM	PA	
Material and operational expenses in kDM	SV	
Investments for the continuing operation in kDM	LI	
DFVLR	Quantitative expenses for personnel and material expenses of the institute	A 063 1971

The numbers of scientific collaborators, technical employees and salaried employees are among the most important quantitative data on the individual institutes and installations. Also the personnel expenditures, the operational expenditures, and the funds for continuing investments are shown.



--- Desired average (71)

Actual average (71)

Expenditures  
in kDM

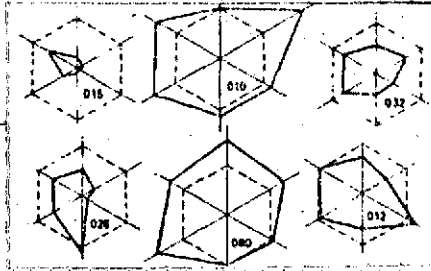
DFVLR

Representation of the quantitative  
data of the research plan

A 060  
1971

In order to give a fast summary on the relationships within an institute and between the various institutes, a computer program has been developed which produces numerical data in the form of a six-sided star. The scale of the six rays is selected so that the average values from the desired values of all the DFVLR institutes would result in a uniform hexagon. The average values of the nominal values deviate from this desired model considerably because of the high contribution of personnel costs.

The meaning of the representation becomes clear if we also show the actual values for the individual institutes. In the example shown here, on the upper left we show a small, primarily theoretical institute. In the lower left there is a



DFVLR	Examples for short descriptions of institutes in the planning year 1971	A 061 1971
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large test facility which produces high operational costs. On the lower right there is an institute which is still under development and has relatively high investment costs. The other three examples show two somewhat larger and one somewhat smaller institute with relatively normal personnel and average proportions.

The representation shown here is only an aid for a quick quantitative evaluation. The question of selection criteria for the advisability of a research topic can be looked upon as being at the other extreme of the selection of problems.

#### A. Scientific criteria:

1. Initial position (status of scientific knowledge methods).
2. Success probability. New scientific results will be found.
3. Importance of possible new knowledge for the general advance of science.
4. Competition situation (type and number of comparison research projects from other areas.)
5. Interdisciplinary relationships (necessity and possibility of collaboration with other disciplines).

DFVLR	Criteria for research support A	A 053 1971
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From the point of view of the DFVLR, we have four groups of such selection criteria. The first group includes urgent scientific criteria, in other words the question of the state of scientific knowledge and the available methods, the question of a chance of succeeding in finding new theoretical knowledge, the question of the importance of the new knowledge for the general advance of science and the question of competition, the number and type of comparable research projects from other areas. Finally there is a question of whether the planned research project could be done in a collaboration with other scientific disciplines and finally, if necessary, whether the conditions for such a collaboration are given. /139

B. Research-political criteria

1. The meaning of possible new knowledge for the general public.
2. Relationship to superior national and international research programs.
3. Correspondence with necessary or desirable accumulation formations.

C. Economical considerations

1. Importance of possible new knowledge for the economy.
2. Relationship to research and development projects of industry.
3. Relationship to actual projects.

DFVLR

Criteria for research support B and C

A 054  
1971

The second group includes criteria of research-politics, the importance of possible new knowledge for the general public (we can only mention environment here), the relationship of the research project to superior national or international research programs and the correspondence with accumulation formations, which are necessary or desirable because of regional, political or educational reasons.

The third group includes the economic criteria, in other words, the criteria which have to do with the importance of new knowledge for the economy, its relationship to research and development projects of industry, and finally the relationship with actual projects being carried out in industry and which the research projects will support.

The three groups of criteria mentioned up to the present approximately correspond to the three groups: science, state and economy. The DFVLR was founded to bring about cooperation among these.

Only scientists can evaluate the state of the art of scientific criteria, because they have the necessary technical knowledge. An objective evaluation will only be found if evaluations are made independent of each other, by both the initiators of the research project as well as by other specialists.

Only the panels responsible for research politics, the parliaments and ministries, can evaluate criteria from the second group.

The economic criteria will probably best be evaluated by the senior representatives of industrial groups.

D Criteria for execution

1. Personnel situation

(Number, suitability, composition and availability of required scientific workers.)

2. Scientific-technical means

(Type, extent and availability of required test facilities, equipment and scientific service organizations.)

3. Financing situation

(Necessary and available funds, use of previous financial expenditures, follow-up costs)

DFVLR Criteria for research requirements D

A 055  
1971

1 ~~All three~~ groups can only reach decisions when a fourth group  
2 of criteria is known, which we will call the criteria of execution.  
3 This includes the following three items: /141

4  
5 How many and what type of scientific workers are required for  
carrying out the projects and which group of persons is available?

What type of test facilities, equipment and other installations  
are required for carrying out the project and what is available?

How much money will the project cost and how much is available?  
By carrying out the project, will it be possible to put previously  
committed funds to better use? Finally, will the project entail  
follow-up costs?

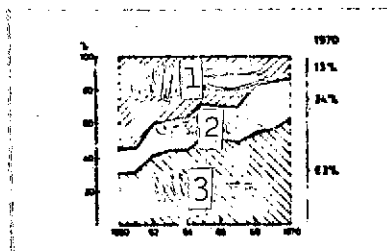
One important task of the research planning group of the  
DFVLR is to develop data from experience and directives for this  
group of criteria of execution, and also to develop methods for  
rapid evaluations.

By comparison of these four groups of criteria, we find that  
a decision on a research project will involve the participation  
of many groups of persons. The decision can only be reached  
within a system of loops which are coupled and interact. This  
will involve an iteration process until a final result is reached.  
At the present time we have just started to deal with the  
problem of developing such a method in a practical way for special  
requirements of the DFVLR. Its solution will be facilitated if  
one only requires a comparison evaluation of several projects.  
It becomes more and more difficult if it becomes necessary for  
the method to produce an absolute evaluation of whether or not  
the project should be supported.

## VI THE FUTURE

Two and one-half years ago the AVA, DFL and DVL were joined together into a single organization. This was done at the request of the Federal Minister for Scientific Research, Dr. Stoltenberg. The purpose was to develop the position of the German aviation and spaceflight organizations to their former status, after almost 10 years of prohibition during the second half of the 50's and during the 60's, during the time of post-war reconstruction.

The major additional tasks which the Federation had taken over in the meantime in the area of education, soon showed that the DFVLR should not be noticeably expanded in the near future.



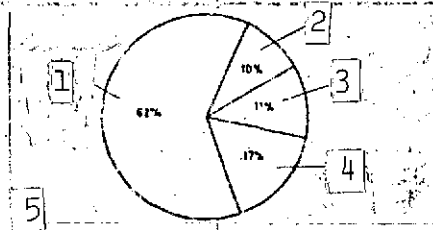
DFVLR	Development of expenditure distribution	A 062
DGF, DFVLR	1960-1970	1971

1- One-time expenditures and construction costs; 2- operational expenditures; 3- personnel expenditures.

In addition we have the rapid increase in personnel costs which in 1960 only made up 1/3, but today already 2/3 of the yearly budget.

Under these conditions, we must make every attempt to further increase the performance of the DFVLR and to have a concentration of research work and a rationalization of working methods structured

according to subject area and location.



DFVLR - Distribution of job plan DFVLR + GfW

A 047  
1971

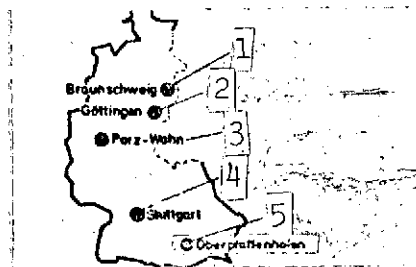
1- research institutes, large scale test facilities, scientific operational facilities; 2- project management; 3- directorate for business administration and administration; 4- central services and facilities; 5- status 1970.

In the position plan of the DFVLR and the GfW, a total of 62% of the jobs involve the research institutes, the large scale test facilities and scientific service organizations: 17% can be attributed to central technical services and installations, 10% for project management and 11% for administration, directorate and business administration.

Any additional rationalization is necessarily limited by the wide geographical distribution and the special features of the research institutes, so that additional centralization of the administration and technical services will be difficult.

As far as the overall scientific activity of the DFVLR is concerned, it is not so much a question of rationalization of the working methods, even though something could be done along these lines, but more a continuous evaluation of the research goals and the formation of scientific and geographical centers.

2 The DFVLR in the past year presented a design for a medium  
3 term research program as a suggestion for developing a center of  
4 major scientific disciplines. No final trends have been developed  
5 along these lines during discussions with scientific personnel  
from all institutes. The discussions in the scientific- / 144  
technical center panels have not yet occurred. The major  
subject area development is being hampered because of uncer-  
tainty of future funding and the long term development programs  
in aerodynamics and spaceflight.



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DFVLR	Goals of subject area centers to be formed	A 051
	in the research centers of the DFVLR	1971

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1- aviation; 2- aerodynamic fundamentals; 3- aerodynamics and  
spaceflight; 4- energy conversion fundamentals; 5- spaceflight.

The question of the development of local centers is somewhat  
simpler. It is influenced by the time and extent of previous  
investments and also partially by the scientific traditions going  
back many years. In the fall of the previous year, the  
scientific management panels and the senate have agreed that over  
the next two years, the Braunschweig Research Center will concen-  
trate on aerodynamics, the Research Center Oberpfaffenhofen will  
concentrate on spaceflight. Those institutes which perform  
research on aircraft will concentrate on this. Goettingen will  
deal with fundamentals of aerodynamics, and Stuttgart will  
work on energy conversion. In the long term, Porz-Wahn will

1 primarily prefer subjects which are important for aviation as  
2 well as for spaceflight.  
3

4  
5 In order to assure that the research centers will not  
become too dependent on unpredictable fluctuations in the  
research economy, such local centers will never be completely  
developed. This also requires time. Only part of the  
scientific workers will support this idea, whereas some of them  
will be its victim. In spite of this, the DFVLR will have to  
advance along the path of a new structuring along geographical and  
disciplinary lines, if it is to remain active.

Independent of these disciplinary and geographical concen-  
trations, a research and test facility such as the DFVLR will  
always have to evaluate the methods of scientific work in two  
ways.

The first way considers the question of a balanced relation-  
ship between theory and experiment. The more expensive an experi-  
mental investigation becomes, the more important it becomes to  
give a theoretical classification of the problem beforehand.  
The further the theoretical methods advance, the more important  
it becomes not to deal in abstract formalism but to always keep  
a relationship with the physical reality.

The second way is concerned with the question of a balanced  
relationship between the expenditure required by a research project  
and the possible useful effect because of the new knowledge. For  
this research the statement by the French aviator and author  
Antoine de Saint-Exupère applies:

5/146

2 "Completeness occurs apparently not when no more can be  
3 added, but when nothing can be removed anymore".  
4  
5

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